



R.C.A. INSTITUTES. INC. *formerly* MARCONI INSTITUTE *Founded 1909*



Technical Lesson 42

THE ELECTRO-DYNAMIC SPEAKER

The electrodynamic speaker differs from the electromagnetic and balanced armature types in that it utilizes no diaphragm as found in the electromagnetic type, or armature as found in the balanced armature type.

Figure 1 is a cross sectional view of the electrodynamic speaker. It consists of a large electromagnet that is energized by passing a current through the coil, shown wound on the center leg of the electromagnet. The two outside legs of this electromagnet center leg is of opposite polarity. When current passes through the coil on the center leg a very strong magnetic field or flux exists between these opposite poles. By referring to Figure 1 it will be seen that the throat or small end of the cone supports a coil of wire within the space between the poles of the electromagnet, the terminals of which lead to the output of the radio receiver. The edge of the cone is supported by a soft leather edge which is screwed fast to the frame of the speaker. With current flowing through the stationary coil a very powerful field is produced between the opposite poles of the electromagnet and embrace the coil wound on the small end of the cone.

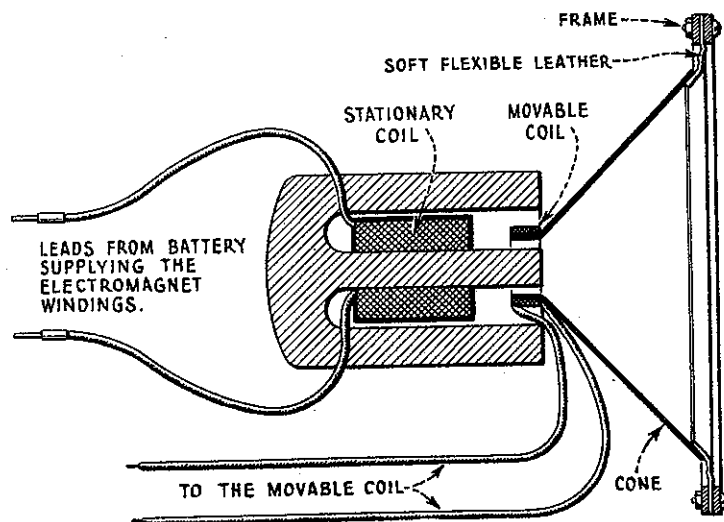


Figure 1

When no current is passing through the small coil connected to the output of the receiver it is non-magnetic and will have no tendency to move. However, as soon as current from the output of the receiver is allowed to pass through the coil wound on the small end of the cone, it sets up a magnetic field of its own. Because the current value changes in this small coil in accordance with the variations in plate current from the

receiver amplifier output its field will also vary.

We now have two distinct and separate magnetic fields. One field is produced by the stationary coil of the electromagnet and is uniform because the coil receives its current from a steady source, such as a storage battery or by means of an eliminator. The small coil on the end of the cone receives its current supply from the receiver output which is constantly varying in accordance with the signal picked up by the receiver.

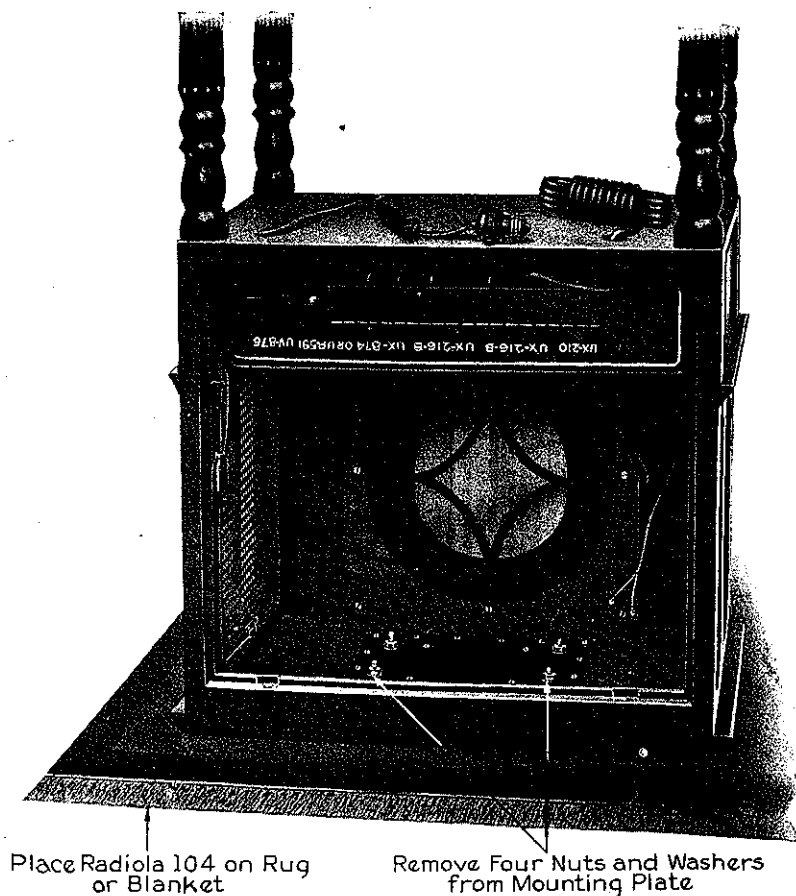


Figure 2

The results produced, therefore, due to the action taking place between the varying field of the small coil and the constant field of the electromagnet tends to set the small coil in motion and it moves back and forth in the electromagnetic field. Since the small coil is wound on the cone itself it is part of the cone and any motion the small coil undergoes must necessarily produce a corresponding motion throughout the entire cone. Since the cone moves it causes the air immediately surrounding it to be agitated thus producing sound waves.

It is on the foregoing principle that the R.C.A. models 104 and 105 speakers operate.

When installing the 104 speaker the first operation is to observe the instructions as shown in Figure 2. Then unpack the loudspeaker unit which will be found in the bottom of the packing case and follow the instructions as set forth in Figure 3, bringing the two field leads which project through the bushings in the rear end of the loud speaker unit down to the top of the cabinet where a clamp will be found. Pass the leads under this clamp and tighten it down. Next set the speaker upright as shown in Figure 4.

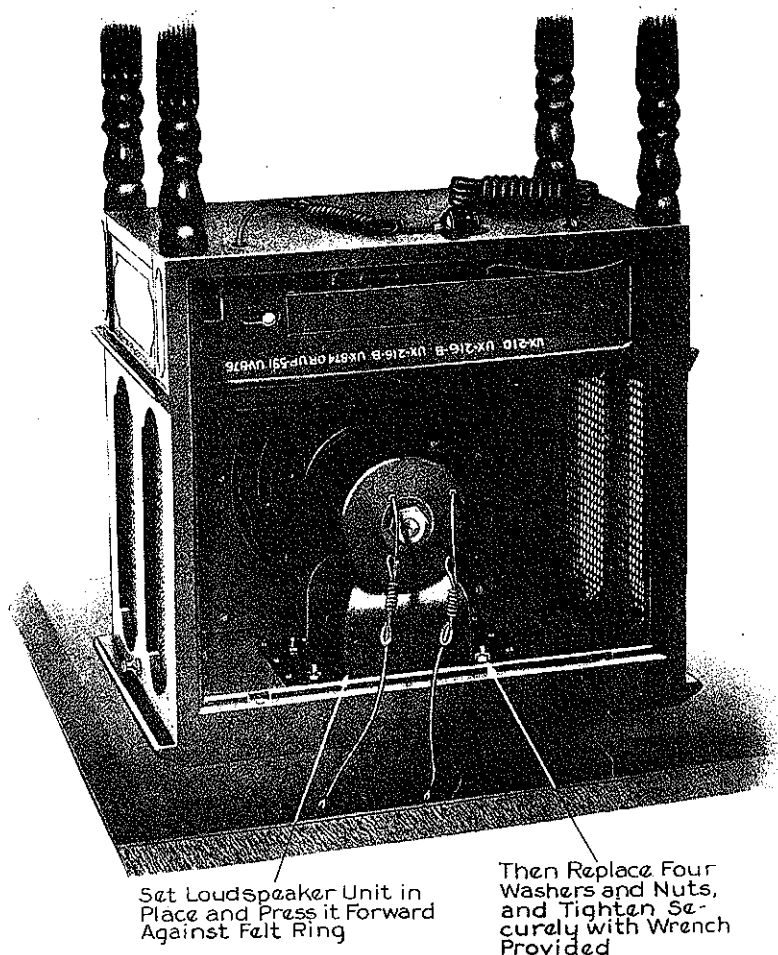


Figure 3

Remove the connection plug shown at the right and push the lock to the right; this allows the hinged door of the Power Amplifier Unit A.P.-951 to be opened. Now connect the terminals of the field leads just clamped to the top of the cabinet to the terminal posts marked "FIELD LEADS" on the amplifier unit. Examine the other cable connections and see that they correspond with the connections shown in Figure 4. Also be sure that the filament jumper connecting terminals 5 and 6, (reading from the left) is closed and that all the screws are properly seated. Unpack the tubes and carefully insert them in the proper sockets as shown in Figure 5. If the frequency and voltage of the lighting circuit to which the speaker is to be connected is between 50 and 60 cycles at 105 to 125 volts alternating current use the UV-876 tube. When 40 to 45 cycles, 105 to 125 volts

alternating current only is available, use the UV-886 tube.

Caution: Do not use the UV-876 on an alternating current supply of a frequency less than 50 cycles.

With the tubes properly seated close the hinged door and (see Figure 6) push the lock knob to the left which locks the door. Insert the connection plug in its socket and place the ventilating stack over the UV-876, or (UV-886 tube), pushing it well down and locking it by turning it to the right. Care should be exercised in handling this stack when the set is in operation as it becomes extremely hot. It should never be handled until after the speaker has been disconnected from the power supply circuit and allowed to cool.

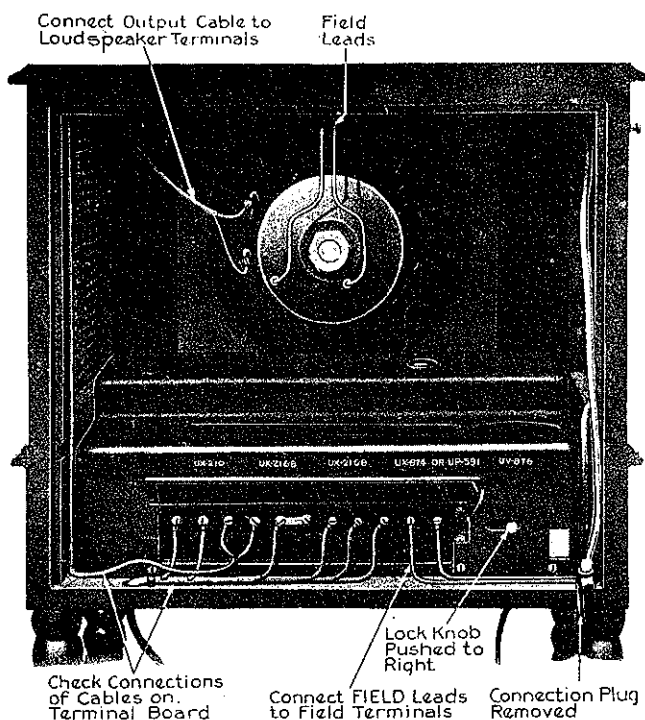


Figure 4

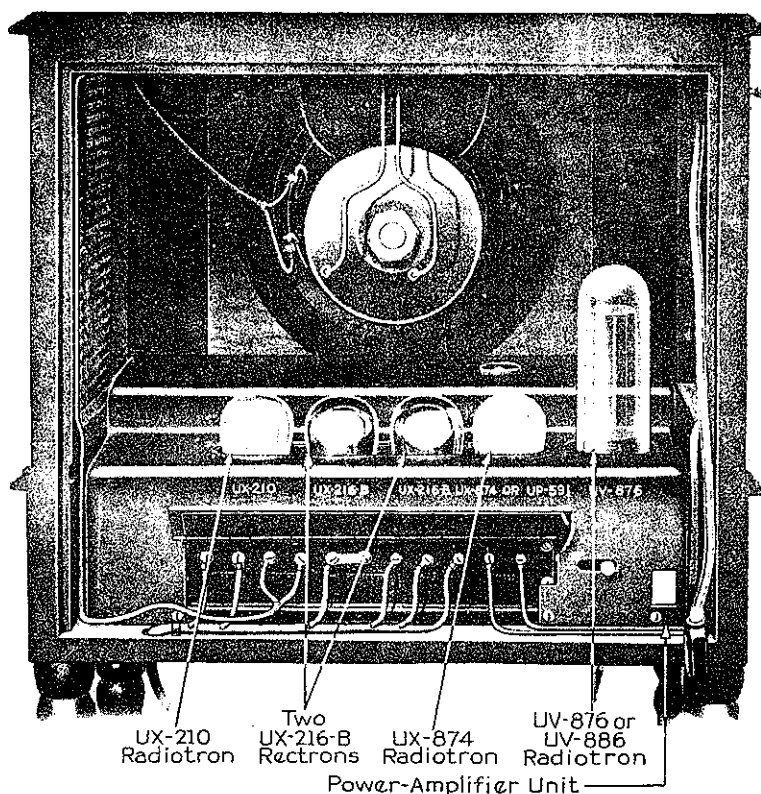


Figure 5

Replace the cabinet door, Figure 7, and connect the speaker to the set with which it is to be used. In connecting the 104 loud speaker to any receiver, other than R.C.A. models, the diagram shown in Figure 8, together with the following instruction, should be followed.

Remove all the "B" batteries from the receiver and, in any convenient place, mount the input terminal board of the loudspeaker. This may be done inside the cabinet or it may be mounted outside the cabinet, providing the five foot telephone cord will reach the telephone jack of the receiver. When the input terminal board of the speaker is installed connect to it

the three leads of the receiver cable formerly connected to the +90, +45 and -B+A, respectively. Plate voltages to 90 volts are now provided. The "A" battery connections of the set should remain unchanged.

If a +135 volt "B" plate voltage was formerly employed be sure this lead is disconnected from any source of potential and the end carefully taped. Examine all remaining battery connections for loose contacts. Remove the second audio frequency tube from its socket and adjust the filament rheostat for proper filament voltage, using as low a setting as possible consistent with good quality of reproduction. The telephone plug from the input terminal board can now be inserted in the first audio frequency jack and the set placed in operation.

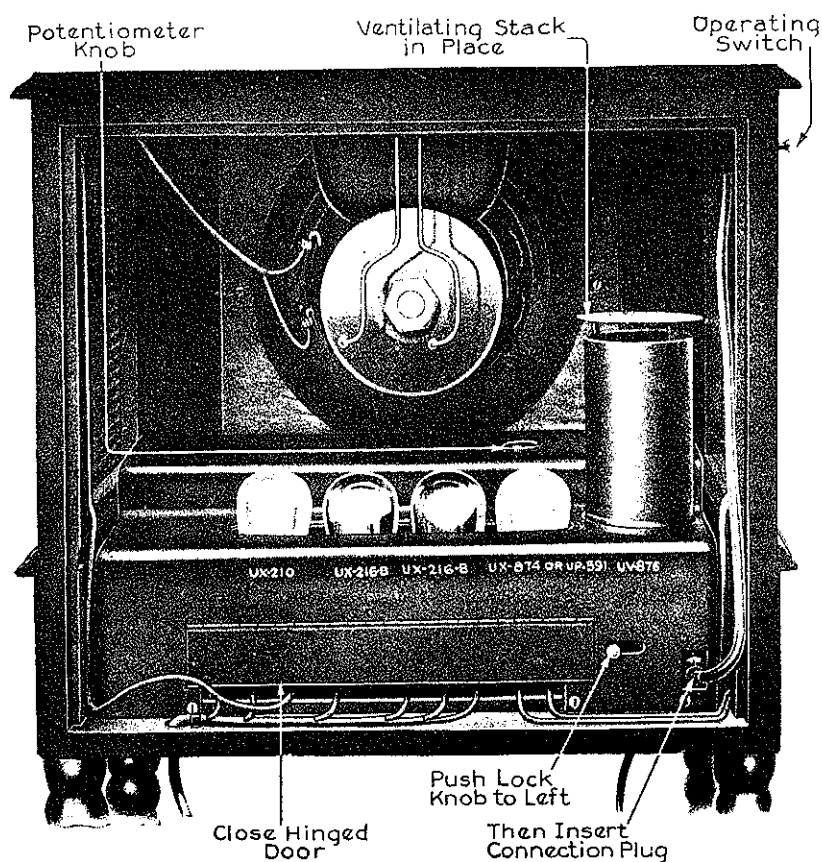


Figure 6

TROUBLES AND REMEDIES

The Rectifier Power Amplifier unit of this speaker employs the following tubes, the use of which will be explained. The UX-210 is a super-power amplifying tube and is capable of handling tremendous volume without distortion. The two 216-B tubes are rectifiers that convert the alternating current from the lighting mains into pulsating direct current. It is

then passed through a filter system which smoothes it out into a continuous direct current.

The UX-874 is a voltage regulating tube which functions to maintain a constant voltage on the plates of the receiving tubes. The UV-876 (and UV-886) are current regulating tubes, generally called "ballast tubes"; their use is to maintain a constant current input to the primary circuit of the power transformer to which they are connected.

The resistance of the filament in these tubes change with every increase or decrease of current. As the current increases the filament resistance increases and when the current decreases the filament resistance decreases. In this manner the current is maintained practically constant. The UV-876 is employed only when the frequency of the house lighting current is between 50 and 75 cycles, while the UV-886 is used when the frequency is between 40 and 45 cycles. Figure 9 shows the internal mechanism and placement of the various parts.

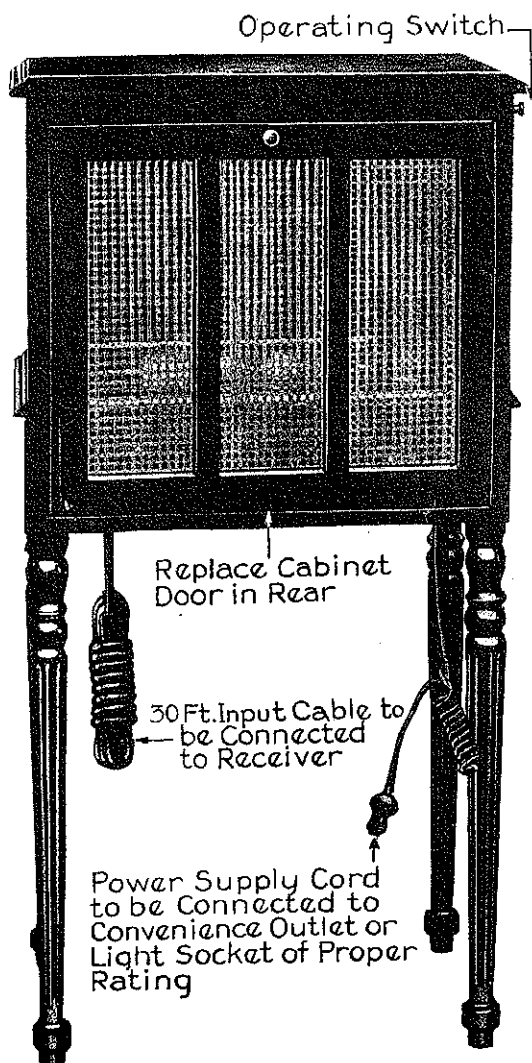


Figure 7

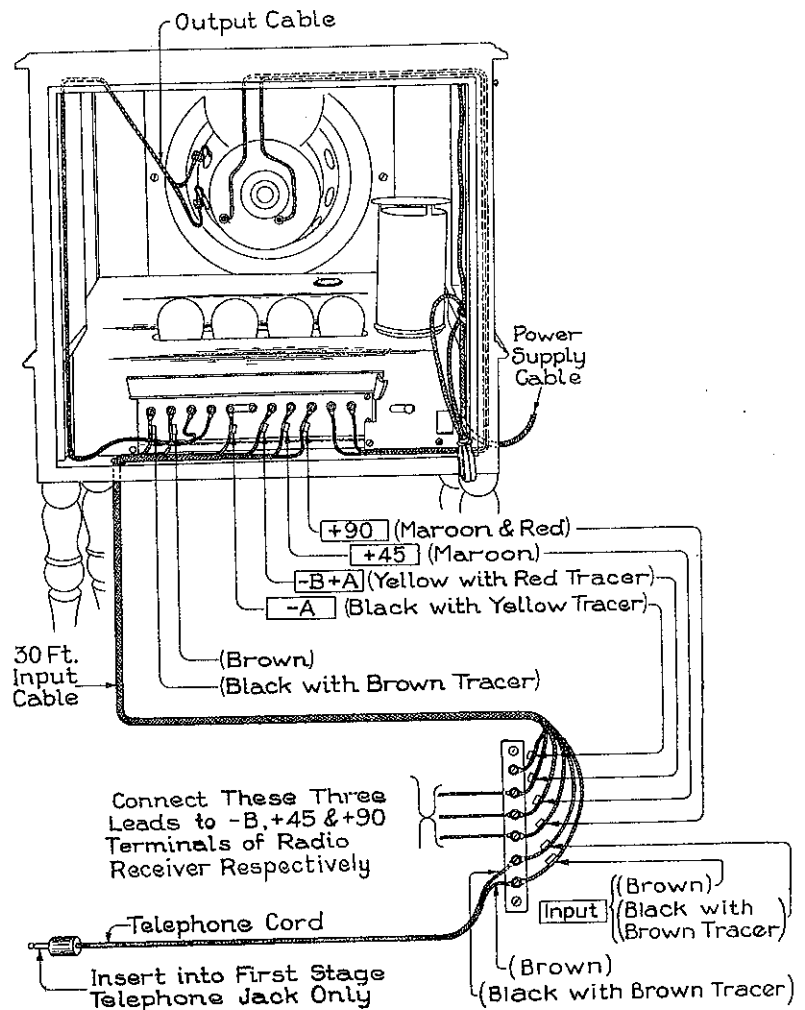


Figure 8

If the speaker should suddenly cease to operate satisfactorily look for the following faults:

One of the three first tubes, counting from the left when facing the back of the speaker cabinet, may cease to operate. It should be replaced by

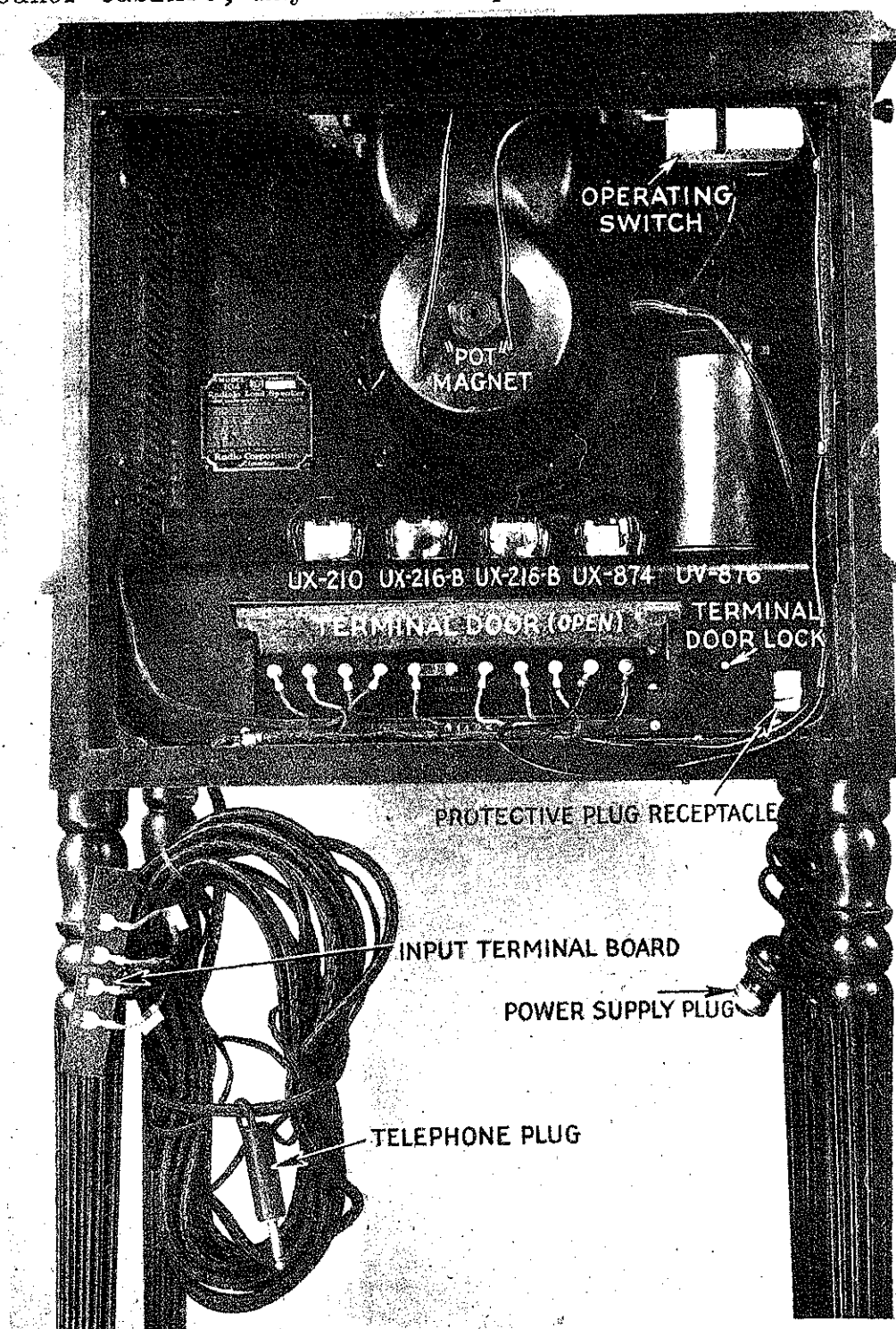


Figure 9

a good tube. The fourth tube from the left, a UX-874, should show a violet or pink glow. If it fails to show this characteristic glow and the three preceeding tubes are functioning replace the UX-874 with a perfect tube. If it fails to glow check the house lighting line voltage. Test the ballast tube, the UV-876 or UV-886 tube, and the 2 mfd. condenser next to the resistance units. See diagram Figure 10. If the voltage reads between 105-125 volts replace the UV-876, or UV-886. If any of the other tubes are found defective, or the condenser short circuited, replace with perfect units. If the UX-874 intermittently flashes when the branch telephone cord is disconnected from the receiver the tube should be replaced with a good one.

Do not confuse a flickering action of this tube with flashing because abnormally strong signals, or heavy static discharges, will produce a slight flickering when the telephone cord is connected to the receiver,

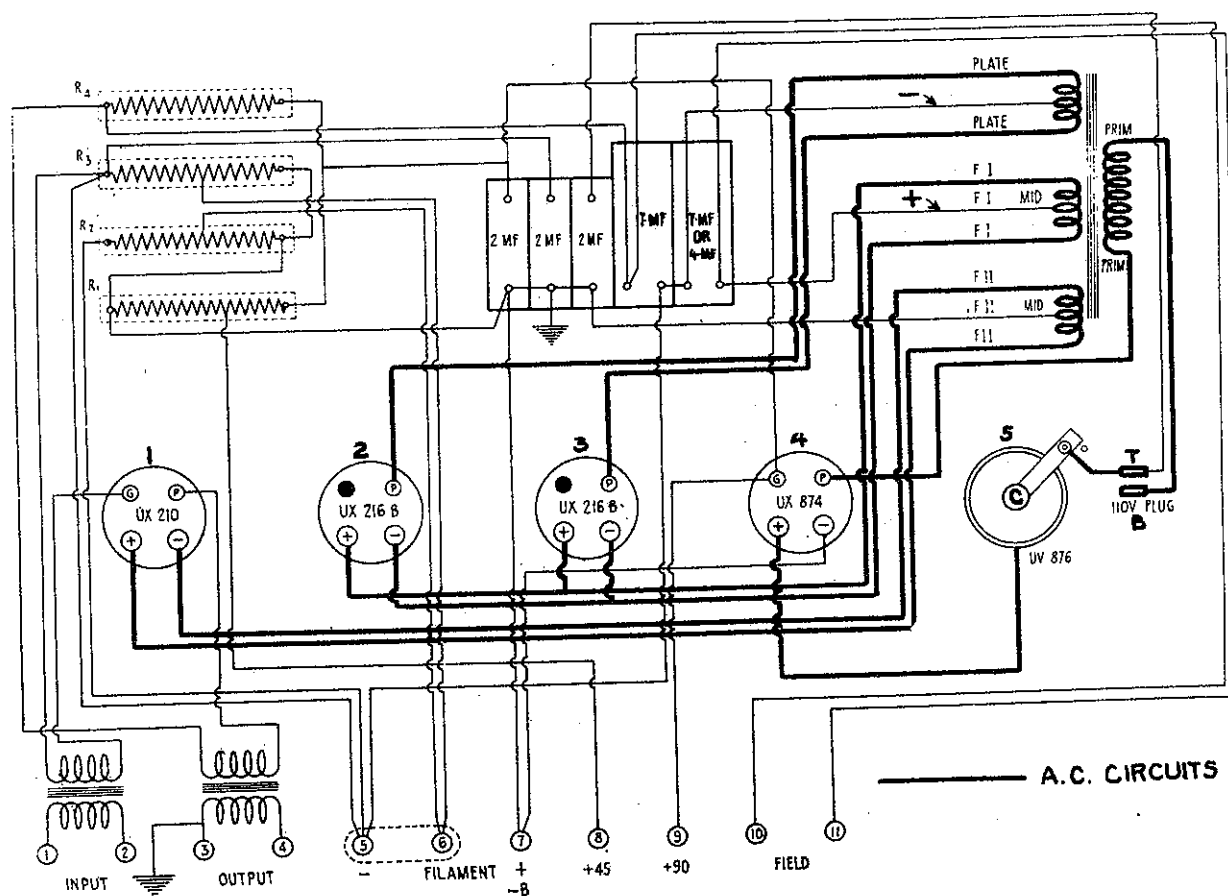


Figure 10

and a prolonged loud signal will decrease the brilliancy of this glow as long as the signal is impressed.

The ballast tube UV-876, or UV-886, as the case may be, has very little or no visible brilliancy relative to the filament. When it is functioning properly it does, however, throw off considerable heat when in operation. If all of the tubes in the Rectifier Power Amplifier fail to light or perform as outlined above make the following check to locate the trouble.

Main current supply from the house mains is not reaching the amplifier; loose connection or blown fuse in house lighting circuit. Poor contact in the operating switch, the location of which is shown in Figure 9.

Protective plug shown in Figure 9 not making proper contact. Tube UV-876 or UV-886, burned out, or not making good electrical contact in socket.

Tube UX-874 defective, or making poor socket connection.

The house lighting current may not be alternating current. If this is the case the filament of the UV-876, or UV-886, will burn at a bright red brilliancy.

NO SIGNALS

When all the tubes are known to be perfect and properly functioning and still no signals are heard from the loud speaker, make a test at the receiver to determine if this part of the apparatus is functioning. If the receiver is working normally look for the following troubles:

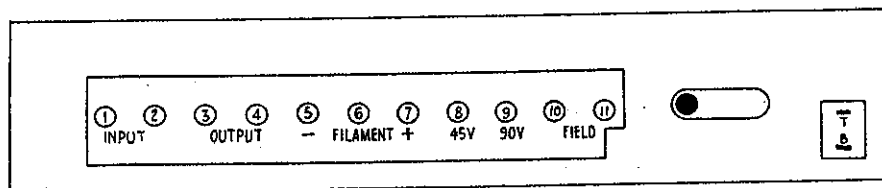


Figure 10A

Telephone plug, cord, or connections are defective.

The cable connections at the input terminals on the Rectifier Power Amplifier terminal board are loose or open.

The 30 foot lighting circuit cable is defective.

The filament of the UX-210 may be touching the grid element, thus causing a filament to grid short.

The grid prongs on any of the tubes may be dirty and not making a good electrical contact.

The small movable coil on the throat of the cone may be open circuited. The Rectifier Power Amplifier unit may be defective. (Method of testing this will be explained under "Continuity test").

REPRODUCER TROUBLE

The large stationary field coil of the Electromagnet (called the pot magnet) may be open. This trouble is easily determined because the UX-210 and UX-216-B tubes will brilliantly light and the UX-874 will not light at all.

The connections marked "Field" on the R.P.A. terminal board may have worked loose thus producing the effect of an open field. If these connections are found to be tight the entire unit will have to be put under test.

EXCESSIVE HUM

This effect is generally caused by:

- (1) A reversed input plug from the alternating current supply source.
- (2) The 2 mfd. condenser located next to the 7 mfd. condenser, Figure 10, short circuited.
- (3) The laminations of the transformer may be loose.
- (4) Power line interference will also cause hum. This can be ascertained by removing the loop or antenna from the set and then noticing if the hum ceases.

UX-210 TUBE TROUBLE

If the plate element of the UX-210 becomes excessively hot cut off the power supply at once and test the following units.

- (1) Test Resistance unit R4, Figure 10, for an open; this is indicated by the plate becoming white hot.
- (2) The 2 mfd. condenser, Figure 10, located next to the resistance units may be short circuited.
- (3) The UX-874 may have developed a short circuit. Replace any of these units found defective.

UX-216-B TUBE TROUBLES

When the UX-216-B plate elements show excessive heat immediately cut off the power supply and check the following units for short circuits.

- (1) The 7 mfd. condenser located between the 7, or 4 mfd., and 2 mfd. condenser. Figure 10.
- (2) The 7 mfd. condenser in extreme right hand unit Figure 10.
- (3) Check for a short circuit in the power transformer, replacing all the defective units.

If one UX-216-B tube becomes red hot while the other apparently remains normal, and no reproduction is heard from the loud speaker unit, the trouble is probably due to a defective UX-216-B. It may appear to be functioning normally; however, it has lost its emission and throws the entire load on the other UX-216-B, causing it to heat excessively. Replace the one which does not show excessive heat.

DISTORTION

Any of the following may cause distortion:

- (1) Faulty or poor input from receiver.
- (2) The 2 mfd. condenser located next to the 7 mfd. condenser, Figure 10.
- (3) The movable coil on the cone may be making electrical contact with the pot magnet producing a short circuit. If so the cone must be replaced.
- (4) Defective UX-210
- (5) Leads of movable coil broken away from cone thus producing a rattle. Shellac them fast.
- (6) The cone may be out of alignment.

The cone is easily re-aligned by removing the front grille work and carefully adjusting the round head screw found in the apex of the cone, as shown in Figure 11. Care should be taken so that the cone is not damaged by the screw driver being pulled out of your control because of the pot magnet located directly back of the cone.

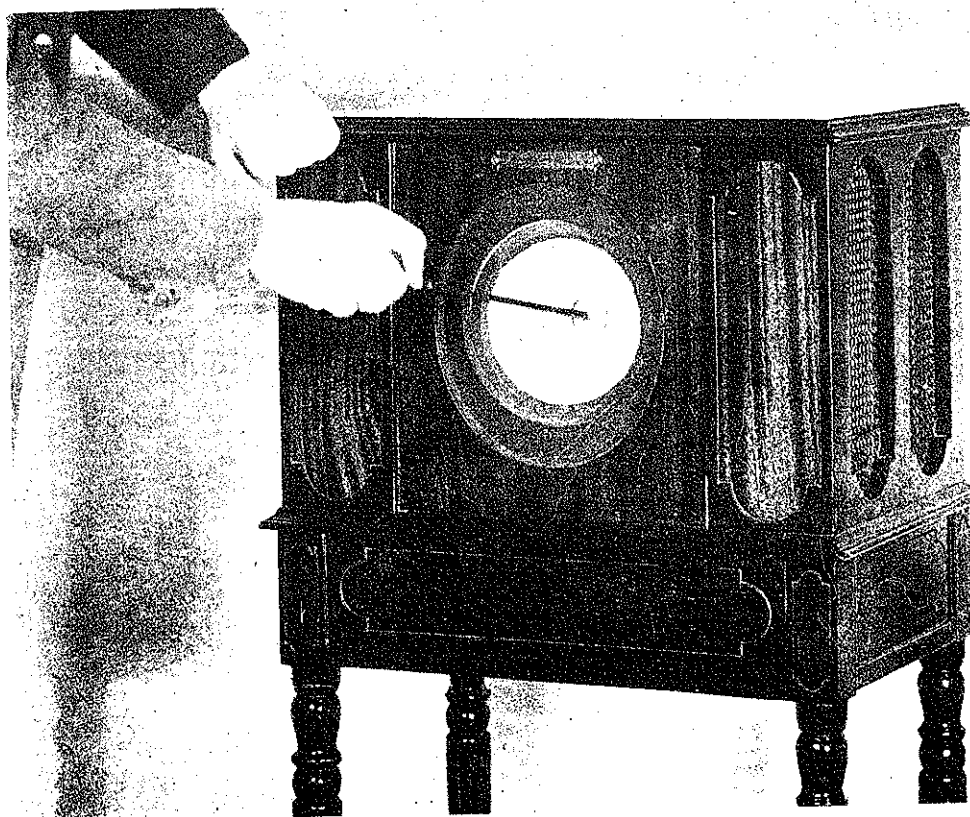


Figure 11

If any of the three 2 mfd. condensers, Figure 10, are leaking, distortion will result. The failure of these condensers is generally accompanied by a loss of filament voltage in the R.P.A. tubes. The defective condenser can be located by disconnecting all cable connections at the R.P.A. terminal board. Remove the metal case and replace all cable connections. Disconnect one of the 2 mfd. condensers, Figure 12, operate the set and note

the resulting reproduction from the loud speaker. If the distortion is still present turn off the input current, replace and solder the connections to the condenser just disconnected, and try the 2 mfd. condenser, repeating this procedure until all the 2 mfd. condensers have been tested.

If distortion is eliminated after a certain condenser is disconnected that condenser must be replaced.

This test should be resorted to only as a last resort. Try all other means possible to correct the distortion before going to this extreme.

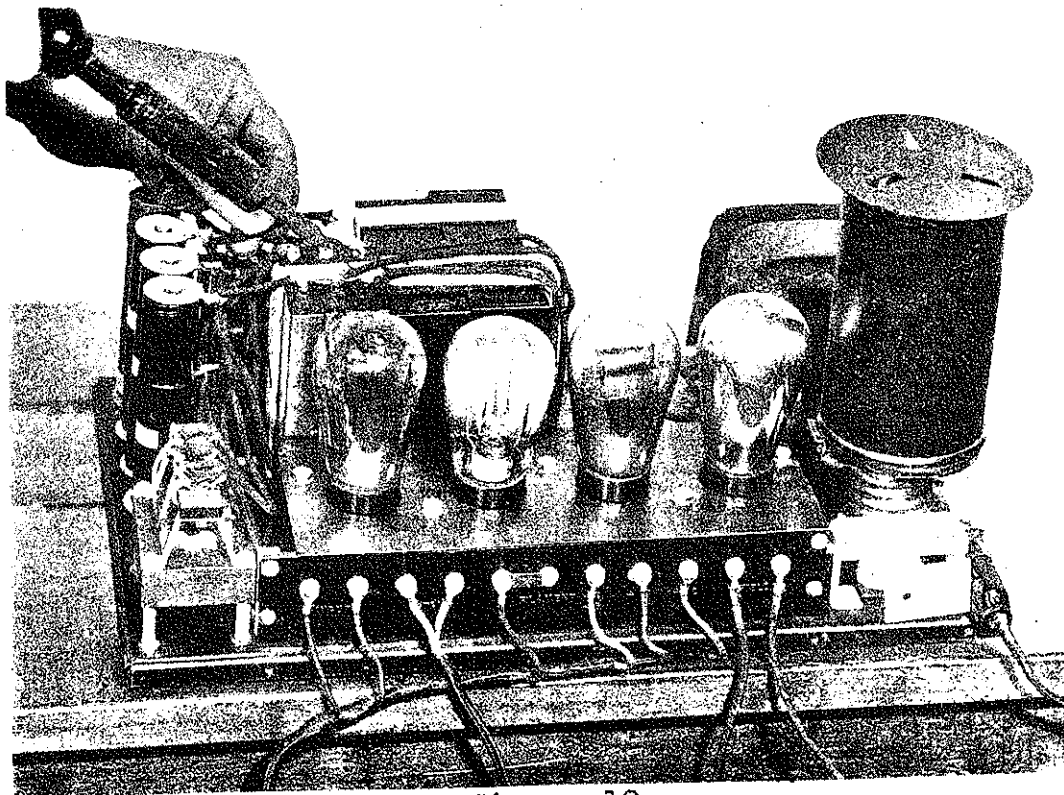


Figure 12

UX-874 TUBE TROUBLE

If the UX-874 does not glow when the power supply is on it is a fair indication that this tube is not receiving the proper voltage supply to cause it to function normally due, probably, to one or more of the following causes.

- (1) The 2 mfd. condenser located next to the resistance units is short circuited. See Figure 10.
- (2) The pot magnet coil may be open.
- (3) The 90 volt connection may be short circuited or open.
- (4) A defective UX-216-B.
- (5) A " UX-874.

NO "B" VOLTAGE

Look for the following defects:

- (1) The 2 mfd. condenser next to the resistance units short circuited. See Figure 10.
- (2) Defective UX-874 tube or socket.
- (3) " UX-216-B " " "
- (4) Short circuited or open "B" voltage connections.

SIGNALS FADE

Signals which fade from causes, other than the normal drop in signal strength, after the speaker has been placed in operation, may be due to the conditions outlined below:

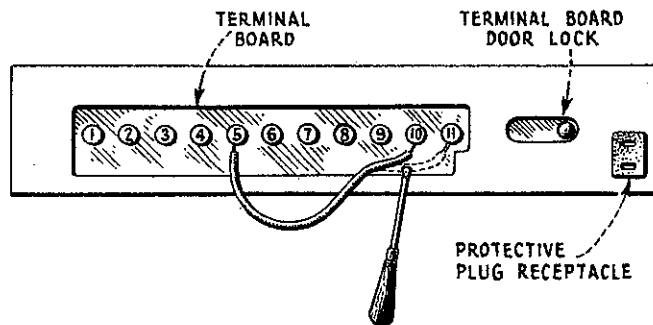


Figure 13

- (1) Defective UX-210 attended by unnatural and raspy reproduction.
- (2) Defective UV-876 or UV-886 tube.
- (3) Defective resistance in R.P.A. unit. The faulty resistor in this case will become excessively hot. This does not apply, however, to resistor R4 which becomes very hot during normal operation.

BLASTING

This trouble may be apparent when operating the 104 speaker with any type of receiver, including the Radiola 25 and 28 super-heterodyne, when completely A.C. operated. Increasing the distance between the receiver and the loudspeaker will in most cases stop the blasting. In some instances interchanging the tubes in the receiver will correct the trouble.

PREPARING FOR THE COMPLETE CONTINUITY TEST

Before a complete continuity test can be conducted on the Rectifier Power Amplifier unit of the 104 loudspeaker remove all the tubes from their sockets and proceed as follows:

Once the speaker has been in operation the 7, and 7 or 4 mfd., condensers build up and often hold a charge. Before doing any work on the

unit it is therefore advisable to short circuit the terminals of this bank of condensers as a precautionary measure. This may be accomplished by short circuiting the connections at the terminal board leading to the terminals of these condensers. Secure a short length of insulated wire, bare both ends, attach one end to contact No. 5 (counting from the left of the terminal board when facing the back of the cabinet), and then force the other end to make contact with terminal No. 10, pushing it into

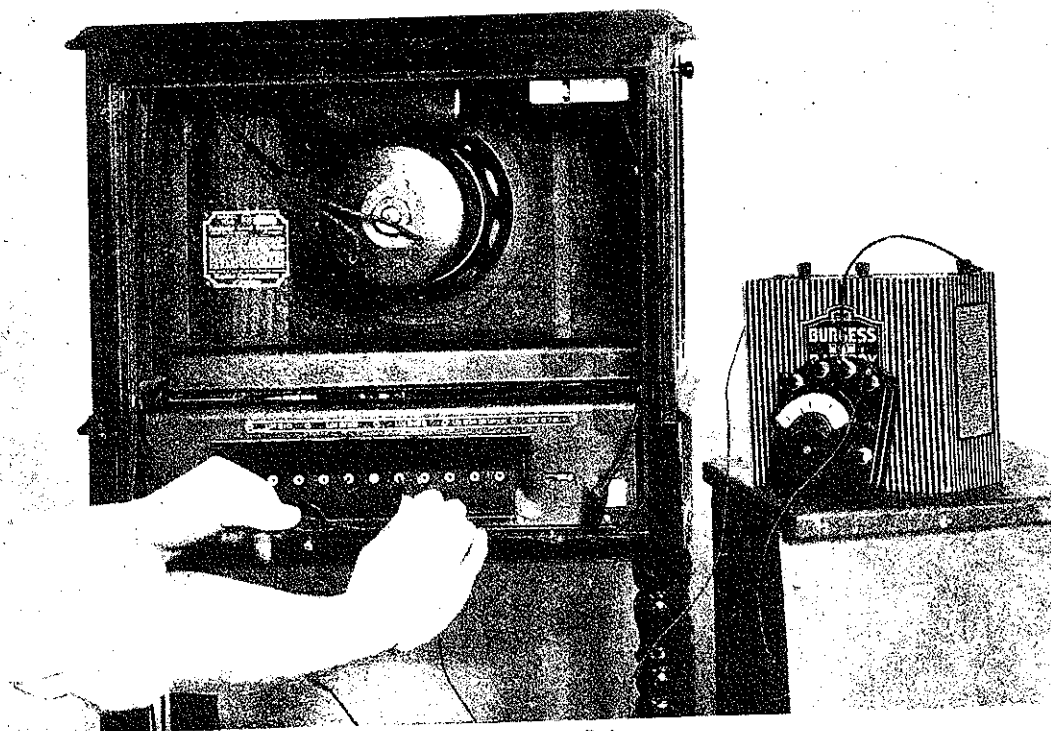


Figure 14

contact with a screw driver possessing an insulated handle. See Figure 13. Repeat this procedure at contact No. 11. The advisability of taking this step is to avoid the possibility of receiving a disagreeable shock if you accidentally make contact. Condensers very often retain a charge for a considerable length of time.

Remove the short circuiting wire and disconnect all the cable connections from the terminal board shown in Figure 12.

The equipment to conduct the test requires a high resistance voltmeter with a battery voltage sufficient to give approximately a full scale deflection when connected directly across the battery terminals. For example, a 45 volt battery connected in series with a voltmeter having a scale reading from zero to fifty volts is satisfactory. The contact points of this testing equipment must not touch any metallic part of the unit except the terminals specified.

Figure 14 shows the testing equipment set up with the test points touching contacts No. 5 and No. 7.

Refer to Figures 10 and 10A as each test is made. Figure 10 is the schematic wiring diagram of the unit, while 10A is a picture diagram of the terminal board.

THE TEST

With one test tip on	And the other test tip on	The voltmeter should show	If the meter shows
Terminal No. 1	Terminal No. 2	A deflection	No deflection, the primary of the input transformer is open
Terminal No. 3	Terminal No. 4	"	No deflection indicates the secondary winding of the output transformer to be open.
Terminal No. 3	Metal frame of unit	"	No deflection indicates that the ground lead is open
Terminal No. 5	To the grid contact of tube socket No. 1	"	No deflection points to an open circuit in the secondary winding of the input transformer
Terminal No. 5	To the plate contact of tube socket No. 2	"	No deflection shows an open circuit in the upper half of the plate winding of the power transformer
Terminal No. 5	To the plate contact of tube socket No. 3	"	No deflection would denote the lower half of the plate winding of the power transformer to be open circuit
Terminal No. 5	Terminal No. 6	"	If no deflection is obtained resistor No. 2 and resistor No. 3 are open circuited
Terminal No. 5	Terminal No. 7	"	If no deflection is obtained resistor No. 2 and resistor No. 3 are open circuited
Terminal No. 7	To negative filament contact of tube socket No. 1	"	No deflection indicates the lower half of filament II winding of the power transformer to be open circuited

Terminal No. 7	To positive filament contact of tube socket No. 1	A deflection	No deflection shows the upper half of filament II winding of the power transformer to be open circuited
Terminal No. 7	To terminal No. 8	"	If the voltmeter needle fails to show a deflection the resistor R1 is open
Terminal No. 7	To negative filament contact of tube socket No. 4	"	No deflection indicates the wire connection between these points is broken or making a poor electrical connection
Terminal No. 8	Terminal No. 9	"	No deflection signifies resistor R1 to be open circuited
Terminal No. 9	To grid contact of tube socket No. 4	"	No deflection shows the connection between these points to be making poor electrical connection
Terminal No. 9	Terminal No. 10	"	No deflection shows resistor R4 to be open circuited
Terminal No. 10	To plate contact of tube socket No. 1	"	No deflection indicates the primary winding of the output transformer to be open circuited
Terminal No. 11	To positive filament contact of tube No. 2	"	No deflection shows the upper half of filament I winding of power transformer to be open circuited
Terminal No. 11	To negative filament contact of tube No. 2	"	No deflection denotes the lower half of filament I winding of the power transformer to be open circuited
Terminal B which is the 110 V plug	To the plate contact of tube socket No. 4	"	No deflection shows the primary winding of the power transformer to be open circuited

The metal shell of the fifth tube socket	To positive fila- ment contact of tube socket No. 4	A deflection	No deflection indi- cates the wire con- nection between these two points to be broken or making poor electri- cal contact.
The center contact of tube socket No. 5	To "T" terminal	"	No deflection indicates the short wire connection between these points open
Terminal No. 5	Terminal No. 11	"	A deflection indicates the 7 or 4 mfd. condenser located next to the power condenser to be short circuited
Terminal No. 5	Terminal No. 10	A small de- flection	If full deflection is obtained the 7 mfd. condenser and first 2 mfd. con- denser to the left is short circuited
Terminal No. 5	Terminal No. 7	"	If full deflection is noted the 2 mfd. condenser, the second condenser to the right from the resistor units, is short circuited
Terminal No. 7	To the center contact of socket No. 5	No deflection	A deflection indicates the third 2 mfd. condenser to the right of resistor units is short cir- cued
Terminal No. 7	Terminal No. 9	A small de- flection	A full deflection shows the 2 mfd. condenser next to the resistor to be open circuited

EXAMINATION - LESSON 42

- (1) In what manner does the Electrodynamic speaker differ materially from the balanced armature type?
- (2) What is the purpose of the stationary coil?
- (3) Explain the purpose of the small wound coil on the throat of the cone.
- (4) What precautions should be observed when it is necessary to work on the UV-876, or UV-886 tube?
- (5) What is the purpose of the UX-216-B tubes?
- (6) Name two reasons why the speaker might suddenly cease to operate.
- (7) Name two mechanical defects that might be the cause of no signals being received.
- (8) What are the precautions to be taken when taking voltmeter readings at the R.P.A. terminal board?
- (9) What effect will loose laminations in the transformer of the R.P.A. unit produce?
- (10) If "blasting" occurs what is likely to be the cause?